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DRUG EFFECTS ON RESPONDING MAINTAINED BY STIMULUS-REINFORCER AND RESPONSE-REINFORCER CONTINGENCIES

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The effects of pentobarbital and *d*-amphetamine were assessed on key pecking by pigeons under conventional single-key multiple schedules and under two-key multiple schedules in which discriminative stimuli appeared on one key (stimulus key) while pecks on a second key (constant key) produced food. Pecks on the stimulus key had no scheduled consequences. A 60-second variable-interval schedule operated in one component of each multiple schedule; either extinction or a 60-second variable-time schedule operated in the alternate component. When the alternate-component schedule was extinction, a high rate of responding was maintained in the variable-interval component of the single-key schedule; responding on both keys was maintained in the variable-interval component of the two-key schedule. Pentobarbital increased responding in the variable-interval component of the single-key schedule and increased stimulus-key, but not constant-key responding in that component of the two-key schedule. When the alternate-component schedule was changed to variable time, responding declined in the variable-interval component of the single-key schedule; stimulus-key responding was no longer maintained under the two-key schedule. Pentobarbital decreased responding in the variable-interval component of both schedules. With an exception, *d*-amphetamine only decreased responding in the variable-interval component of the single- and two-key schedules both when the alternate-component schedule was extinction and when it was variable time. The results suggest that the effects of pentobarbital, but not *d*-amphetamine, depend on the nature of the contingency (stimulus-reinforcer, response-reinforcer) that maintains responding.

Key words: stimulus-reinforcer contingencies, response-reinforcer contingencies, pentobarbital, *d*-amphetamine, multiple schedules, key peck, pigeons

Under conventional multiple schedules, two or more component schedules of reinforcement operate successively, and different components are associated with different discriminative stimuli (Ferster and Skinner, 1957). Although responding in each component is maintained by its consequences (response-reinforcer contingencies), recent studies have demonstrated additional influences on responding under multiple schedules. Different rates of reinforcement in the presence of different discriminative stimuli (stimulus-reinforcer contingencies) can also contribute importantly to the maintenance of responding (see reviews by Hearst and Jenkins, 1974; Rachlin, 1973; Schwartz and Gamzu, 1977).

Keller (1974) described a technique for assessing the contributions of response-reinforcer and stimulus-reinforcer contingencies to the maintenance of responding under multiple schedules. In his study, pigeons were exposed to multiple schedules in which two keys were illuminated at all times. One key (constant key) was illuminated continuously with a constant stimulus. Pecks on this key produced food according to the component schedules. The other key (stimulus key) was illuminated with a different stimulus in each component. Pecks on this key had no scheduled consequences. Keller's results and those of others (Schwartz, 1975; Schwartz, Hamilton, and Silberberg, 1975; Spealman, 1976) confirmed that responding under two-key multiple schedules was maintained not only by the contingency

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between response and reinforcer, but also by the contingency between stimulus and reinforcer. In these studies, stimulus-key responding occurred when different rates of food presentation were arranged in the different components (that is, when a stimulus-reinforcer contingency existed), but not when food was presented at equal rates in each component (when the stimulus-reinforcer contingency was eliminated). Constant-key responding, on the other hand, continued to occur regardless of the presence or absence of the stimulus-reinforcer contingency, as long as the response-reinforcer contingency remained intact. Thus, responding maintained by each contingency was "topographically tagged" (*cf.* Catania, 1971; 1973). These results provide direct support for an "additivity" account of performance under conventional multiple schedules (*cf.* Schwartz and Gamzu, 1977); responding under single-key multiple schedules could be synthesized by summing responses on both keys under the comparable two-key schedules (Keller, 1974; Schwartz, 1975; Spealman, 1976).

Two-key multiple schedules can provide useful baselines for assessing the effects of environmental variables on responding maintained by stimulus-reinforcer and response-reinforcer contingencies. Spealman (1976), for example, studied the effects of component duration on responding under two-key multiple schedules. Different rates of food presentation were arranged in the different components, and responding was maintained on both keys. The rate of stimulus-key responding varied inversely as a function of component duration, whereas the rate of constant-key responding was affected unsystematically. Thus, changes in component duration had selective effects that depended on the nature of the contingency (stimulus-reinforcer, response-reinforcer) that maintained responding.

Other variables may also have selective effects on responding maintained by the two contingencies. Recent studies in behavioral pharmacology have demonstrated that the effects of drugs can depend critically on the nature of event that maintains responding (Barrett, 1976; McKearney, 1974). In these studies, some drugs (*e.g.*, pentobarbital) increased responding maintained by a response-food presentation contingency, but only decreased responding maintained by a comparable response-shock presentation contingency. Other drugs (*e.g.*, *d*-amphetamine) affected responding similarly regardless of the event that maintained responding. It is entirely conceivable that drugs also have selective effects that depend on the nature of the contingency, rather than the nature of the event that maintains responding. The present study investigated this possibility.

The behavioral effects of pentobarbital and *d*-amphetamine were compared under two-key multiple schedules of food presentation with pigeons. These drugs were chosen for study on the basis of the effects reported by McKearney (1974) and Barrett (1976). In the first comparison, drugs were given when responding was maintained under a multiple variable-interval extinction (*mult* VI EXT) schedule. Under this schedule, both a response-reinforcer and a stimulus-reinforcer contingency existed, and responding was maintained on both keys. Of primary interest was the extent to which the drugs selectively affected stimulus-key and constant-key responding. Selective drug effects would be compatible with an account of responding on the two keys based on independent maintenance by the extant response-reinforcer and stimulus-reinforcer contingencies. In the second comparison, drugs were given when responding was maintained under an equal-valued multiple variable-interval variable-time (*mult* VI VT) schedule. Under this schedule, only a response-reinforcer contingency existed, and responding was confined primarily to the constant key. This schedule allowed an additional comparison of the effects of the drugs on constant-key responding in the absence of appreciable stimulus-key responding.

The effects of the drugs were also compared under conventional single-key *mult* VI EXT and *mult* VI VT schedules of food presentation. Under these schedules, the stimuli associated with different components were displayed on the key on which responses produced food. Of primary interest in these comparisons was the extent to which the effects of the drugs under the single-key schedules could be synthesized by considering the effects on total response output (the sum of stimulus-key and constant-key responses) under the comparable two-key schedules. A synthesis of this sort would be predicted from an "additivity" account of responding under conventional multiple schedules.

METHOD

Subjects

Five adult male White Carneaux pigeons were maintained at about 80% of their unrestricted-feeding weights (about 450 to 550 g) and had unlimited access to water in their home cages. Each pigeon was studied previously under either single-key (P-19, P-24) or two-key (P-21, P-72, P-287) multiple schedules (Spealman, 1976). P-21 died after the drug comparison under the *mult* VI EXT schedule was completed.

Apparatus

A two-key chamber was constructed of clear Plexiglas and measured 33.5 cm high by 35.0 cm long by 35.0 cm wide. Except for the front panel and a 6.5-cm by 6.0-cm portion of the right side wall, the inside of the chamber was painted flat black to reduce reflections. Each key (R. Gerbrands Co.) was located 25.5 cm above the floor and centered 3.0 cm to one side of the vertical midline of the front panel. A minimal force of 0.15N on either key defined a response and operated the recording equipment. The right (constant) key was transilluminated by a white light; the left (stimulus) key was transilluminated by either a red or a green light. Each keylight (7 W, 115 V ac) was shielded behind the front panel to prevent stray light from illuminating the other key, the feeder opening, or other features of the chamber. The feeder opening was centered 17.5 cm below the keys and was illuminated by two white lamps (6 W, 115 V ac) when operated. A single white lamp (6 W, 115 V ac) was centered at the top of the front panel and provided continuous overall illumination. The chamber was housed inside a sound-attenuating enclosure provided with an exhaust fan and white masking noise. A wide-angle lens was mounted in the enclosure in front of the unpainted portion of the chamber wall. Relay scheduling and recording equipment was located in an adjacent room.

Procedure

Since all subjects had been studied previously under similar schedules, no preliminary training was required. Each pigeon was exposed first to a multiple 60-sec variable-interval, extinction (*mult* VI 60-sec EXT) schedule of food presentation. The VI schedule consisted of a constant-probability distribution (Catania and Reynolds, 1968) of 15 different time intervals arranged in an irregular order. Food presentations (access to mixed grain) lasted 4 sec, during which the feeder was lighted and the keys were dark. The VI and EXT components alternated every 60 sec. Each component was associated with a different color (red or green) of the stimulus key. Component changes scheduled while the feeder was operated were delayed until the end of food presentation. Scheduled food presentations not produced by a key peck were cancelled following component change. Sessions lasted 1 hr and were conducted five days per week.

For P-19 and P-24, responses on the white constant key had no scheduled consequences. Responses on the stimulus key, when green, produced food according to the VI schedule; responses on the stimulus key, when red, never produced food. Since responding rarely occurred on the constant key, this schedule is referred to as a *single-key mult* VI EXT schedule, although two keys were present. For P-21, P-72, and P-287 responses on the stimulus key had no scheduled consequences. When the stimulus key was red (green for P-287), responses on the white constant key produced food according to the VI schedule; when the stimulus key was green (red for P-287), responses on the constant key never produced food. This schedule differs from the single-key multiple schedule in that the stimuli associated with components of the multiple schedule appeared on one key while responses on the other key produced food. This schedule is referred to as a *two-key mult* VI EXT schedule.

After 20 to 27 sessions of exposure to the *mult* VI EXT schedules and when no consistent trend in responding was apparent for at least five consecutive sessions, each pigeon received *d*-amphetamine sulfate and pentobarbital sodium. Drugs were dissolved in 0.9% saline solution and were injected in a volume of 1.0 ml/kg body weight. Similar volumes of 0.9% saline solution served as control injections. Drugs or saline were injected into the pectoral muscle immediately before a session. All doses are expressed as the salt and were administered in mg/kg body weight. Each pigeon typically received two administrations of each dose of *d*-amphetamine (0.1 to 5.6 mg/

kg) and pentobarbital (1.0 to 17.0 mg/kg), as well as saline. In most cases, however, the 5.6-mg/kg dose of *d*-amphetamine and the 17.0-mg/kg dose of pentobarbital were given once. Drugs were administered in irregular order of dose, not more than twice weekly (usually on Tuesdays or Fridays). Sessions on Thursdays preceding drug sessions served as noninjection or saline controls. The *d*-amphetamine series was completed before the pentobarbital series was begun.

After the pentobarbital series was completed, the EXT component was changed to a 60-sec variable-time (VT 60-sec) schedule of food presentation. The VT schedule was identical to the VI schedule except that food was presented independently of responding. After 25 to 35 sessions of exposure to the *mult* VI VT schedule and when no consistent trend in responding was apparent for at least five consecutive sessions, each pigeon again received a complete series of *d*-amphetamine and pentobarbital doses as described above. Table 1 shows the sequence of conditions and doses, and the number of control sessions during each drug series for individual pigeons.

RESULTS

Two-key procedure. Under the two-key *mult* VI EXT schedule, moderate and relatively constant rates of both stimulus-key and constant-key responding were maintained in the VI component throughout each session (Figure 1, panel A). The rate of responding on the constant key approximately equalled the rate of responding on the stimulus key for P-72 and P-287; the rate of constant-key responding exceeded that of stimulus-key responding for P-21 (Figure 2, control). Very low rates of stimulus-key and constant-key responding occurred in the EXT component for each pigeon.

Pentobarbital selectively increased stimulus-key responding in the VI component (Figure 2, unfilled circles). For each pigeon, some doses of pentobarbital increased the rate of responding on the stimulus key (left panels); these same doses either had little effect on or decreased the rate of responding on the constant key (right panels). Higher doses of pentobarbital decreased responding on both keys. In contrast, *d*-amphetamine (filled circles) did not increase stimulus-key responding in the VI

Table 1

Sequence of conditions and doses, and number of control sessions (Thursdays) during the *d*-amphetamine and pentobarbital series.

	Schedule		*d-Amphetamine Series*		*Pentobarbital Series*	
Pigeon	*Red*	*Green*	*Control Sessions*	*Sequence of Doses (mg/kg)*	*Control Sessions*	*Sequence of Doses (mg/kg)*
				TWO-KEY SCHEDULE		
P-21	VI	EXT	5	3.0, 0.3, 1.0, 3.0, 0.1, 1.0, 0.1, 5.6, 0.3	6	5.6, 10.0, 10.0, 1.0, 3.0, 17.0, 5.6, 3.0, 1.0
P-72	VI	EXT	7	1.0, 3.0, 0.3, 1.0, 3.0, 0.3, 0.1, 0.1, 5.6	6	3.0, 10.0, 5.6, 1.0, 17.0, 5.6, 3.0, 1.0
	VI	VT	6	1.0, 0.3, 0.1, 1.0, 0.3, 0.1, 3.0, 5.6, 3.0	6	3.0, 5.6, 1.0, 10.0, 3.0, 5.6, 17.0, 1.0, 10.0
P-287	EXT	VI	5	3.0, 0.3, 1.0, 3.0, 0.1, 0.3, 5.6, 0.1, 1.0	5	10.0, 5.6, 1.0, 17.0, 3.0, 10.0, 17.0, 5.6, 1.0, 3.0
	VT	VI	5	1.0, 0.3, 1.0, 3.0, 0.3, 1.0, 0.1, 0.1, 5.6	5	10.0, 5.6, 10.0, 3.0, 5.6, 3.0, 17.0, 1.0, 1.0
				SINGLE-KEY SCHEDULE		
P-19	EXT	VI	5	1.0, 3.0, 0.3, 3.0, 1.0, 0.3, 5.6, 0.1, 0.1	5	5.6, 3.0, 10.0, 1.0, 17.0, 1.0, 5.6, 3.0, 10.0
	VT	VI	5	1.0, 0.3, 3.0, 0.3, 0.1, 3.0, 1.0, 5.6, 0.1, 5.6	5	10.0, 5.6, 1.0, 3.0, 10.0, 3.0, 5.6, 1.0, 17.0
P-24	EXT	VI	5	1.0, 0.3, 3.0, 1.0, 0.3, 3.0, 0.1, 5.6, 0.1	6	10.0, 5.6, 3.0, 17.0, 1.0, 5.6, 3.0, 10.0, 17.0, 1.0
	VT	VI	5	0.1, 3.0, 0.1, 1.0, 0.3, 1.0, 3.0, 0.3, 5.6	5	5.6 , 17.0, 3.0, 1.0, 3.0, 10.0, 1.0, 5.6, 10.0, 17.0

component at any dose studied, but rather decreased responding at higher doses. With the exception of P-72, *d*-amphetamine also had little effect on (lower doses) or decreased (higher

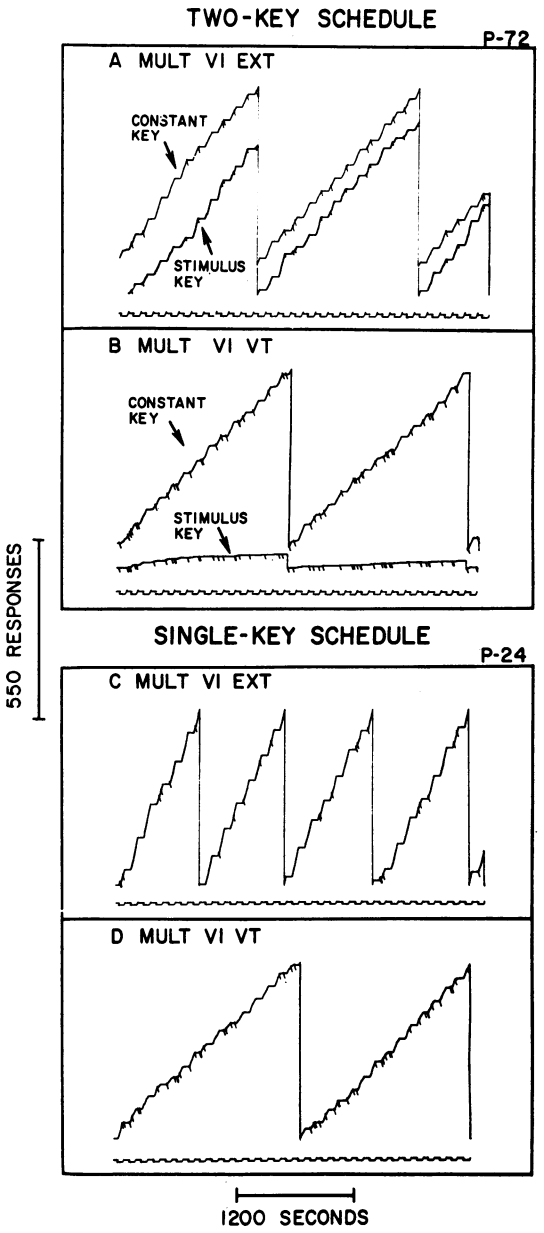

Fig. 1. Cumulative records showing control performances typical of those maintained under the two-key (P-72) and single-key (P-24) *mult* VI EXT and *mult* VI VT schedules. Abscissae: time; ordinates: cumulative key pecks. The upper and lower records in panel A show constant-key and stimulus-key pecking, respectively, under the two-key *mult* VI EXT schedule; panel B shows responding under the two-key *mult* VI VT schedule. Panels C and D show stimulus-key pecking under the single-key *mult* VI EXT and *mult* VI VT schedules, respectively. Diagonal marks on the response pens show food presentations. The event pen was deflected downward during the EXT or VT components. Note that the total response output was higher under the *mult* VI EXT schedules than under the *mult* VI VT schedules.

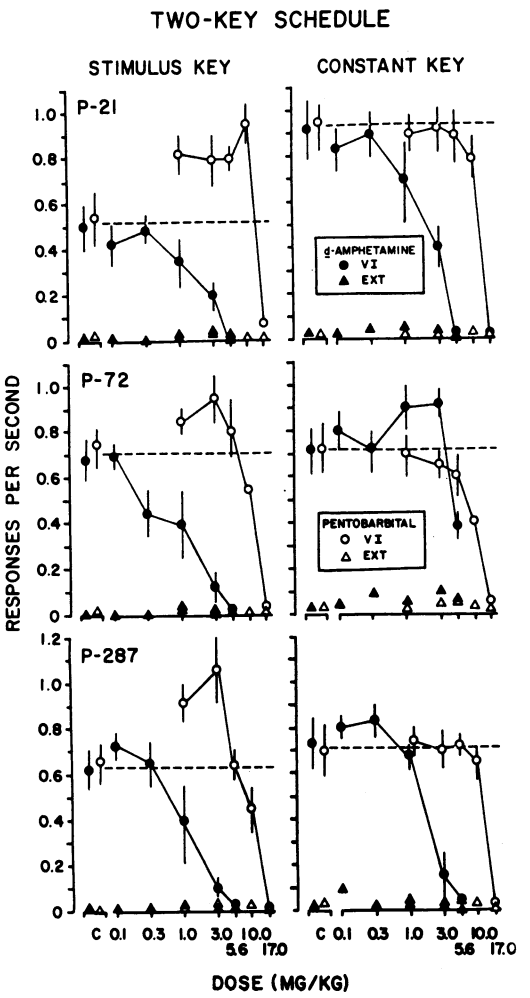

Fig. 2. Effects of *d*-amphetamine and pentobarbital on stimulus-key and constant-key pecking under the two-key *mult* VI EXT schedule for individual pigeons. Abscissae: dose, log scale; ordinates: rate of responding. Points at C are means based on five to seven control sessions when the pigeons were not injected or were injected with saline. Separate control points are shown for the *d*-amphetamine and pentobarbital series; dashed horizontal lines show the mean control rate for both series. Each other point is either a single determination or the mean of two determinations. Vertical lines show ranges.

doses) constant-key responding in the VI component. Some doses of each drug produced small increases in the very low rate of responding on both keys in the EXT component (triangles).

When the schedule was changed to *mult* VI VT for P-72 and P-287, the rate of stimulus-key responding declined to a very low level in the VI component (Figure 1, panel B; Figure 3). The rate of responding on the constant key was affected unsystematically by the same schedule change; constant-key responding in the VI component declined slightly for P-72, but increased for P-287. Only low rates of responding on both keys occurred in the VT component.

The effects of pentobarbital and *d*-amphetamine on constant-key responding under the *mult* VI VT schedule were similar to those under the *mult* VI EXT schedule. With the exception of 1.0 mg/kg of *d*-amphetamine for P-72, each drug had little effect on (lower doses) or decreased (higher doses) constant-key responding in the VI component (Figure 4, right panels). Thus, the effects of the drugs

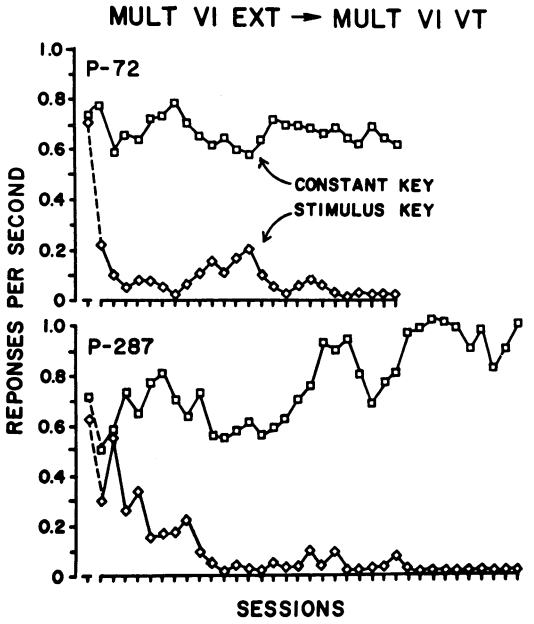

Fig. 3. Effects of changing the two-key *mult* VI EXT schedule to *mult* VI VT on stimulus-key and constant-key responding in the VI component. Abscissae: consecutive sessions; ordinates: rate of responding. The leftmost points connected by dashed lines show the mean rate of responding on the two keys during all control sessions (13 for P-72, 10 for P-287) under the *mult* VI EXT schedule; ranges are as in Figure 2.

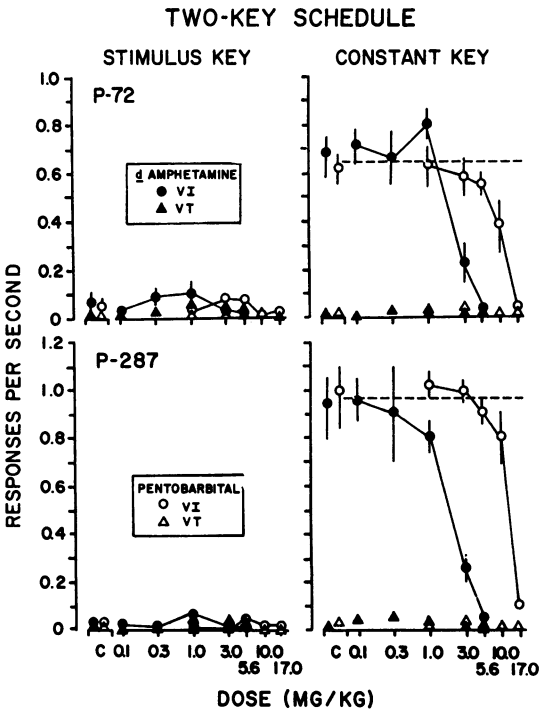

Fig. 4. Effects of *d*-amphetamine and pentobarbital on stimulus-key and constant-key pecking under the two-key *mult* VI VT schedule for individual pigeons. Points at C are means based on five or six control sessions. Other details are as in Figure 2.

on constant-key responding in the VI component did not depend greatly on whether the schedule in the alternate component was EXT or VT. Some doses of each drug produced small increases in the low rate of stimulus-key responding in the VI component (left panels) and in responding on both keys in the VT component.

Single-key procedure. Under the single-key *mult* VI EXT schedule, high and relatively constant rates of stimulus-key responding were maintained in the VI component, while very low rates occurred in the EXT component (Figure 1, panel C). Constant-key responding (not shown) almost never occurred in either component and was not affected systematically by either drug. For each pigeon, some doses of pentobarbital increased responding in the VI component; higher doses decreased responding (Figure 5, left panels). Unlike pentobarbital, *d*-amphetamine either had little effect on (lower doses) or decreased (higher doses) responding in the VI component. Some doses

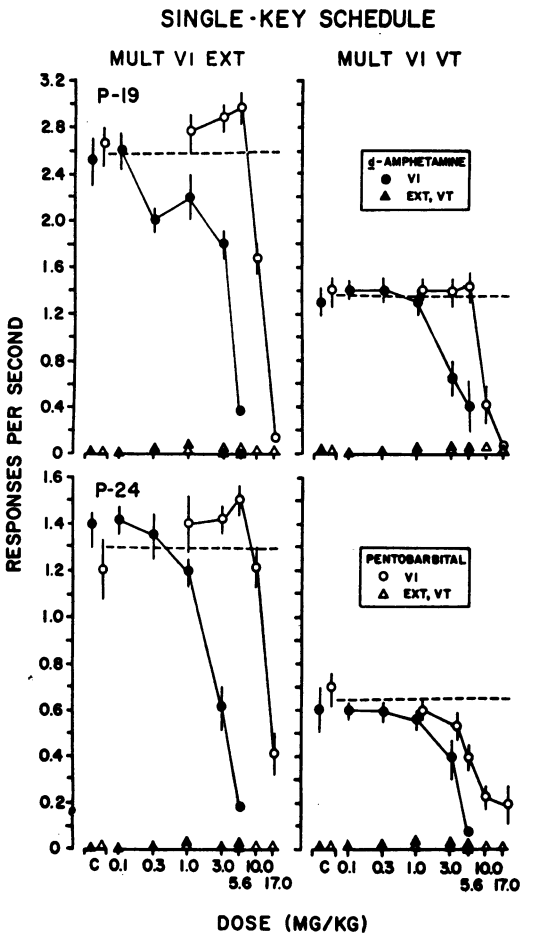

Fig. 5. Effects of *d*-amphetamine and pentobarbital on stimulus-key pecking under the single-key *mult* VI EXT and *mult* VI VT schedules for individual pigeons. Points at C are means based on five or six control sessions. Constant-key pecking rarely occurred and is not shown. Other details are as in Figure 2.

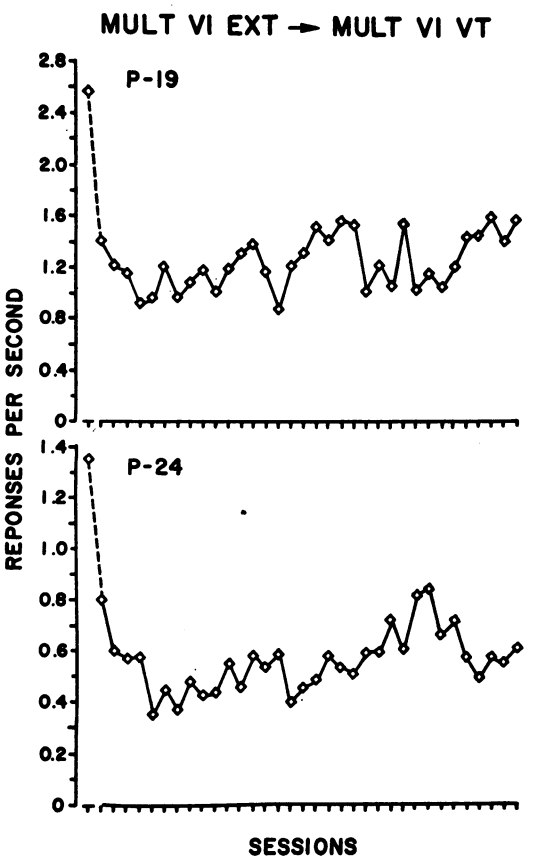

Fig. 6. Effects of changing the single-key *mult* VI EXT schedule to *mult* VI VT on stimulus-key responding in the VI component. Abscissae: consecutive sessions; ordinates: rate of responding. The left-most points connected by dashed lines show the mean rate of responding during all control sessions (10 for P-19, 11 for P-24) under the *mult* VI EXT schedule; ranges are as in Figure 5.

of each drug produced small increases in the low rate of responding in the EXT component.

When the *mult* VI EXT schedule was changed to *mult* VI VT, the rate of stimulus-key responding declined markedly in the VI component (Figure 1, panel D; Figure 6). Stimulus-key responding remained at a low level in the VT component. Again, constant-key responding almost never occurred in either component and was not affected systematically by the drugs. Neither pentobarbital nor *d*-amphetamine increased responding in the VI component at any dose studied, but rather decreased responding at the higher doses (Figure 5, right panels). Thus, the effects of pentobarbital, but not of *d*-amphetamine depended on whether the schedule was *mult* VI EXT or *mult* VI VT. Some doses of each drug produced small increases in stimulus-key responding in the VT component.

To compare the effects of pentobarbital and *d*-amphetamine on total response output under the single-key and two-key procedures, responses on each key were added together under the two-key multiple schedules (Figure 7). Under the *mult* VI EXT schedule, a relatively high rate of stimulus-key *plus* constant-key pecking was maintained in the VI component (left panel). Some doses of pentobarbital, but not *d*-amphetamine increased the total response output in that component. Under the *mult* VI VT schedule, a lower total response output was maintained in the VI component

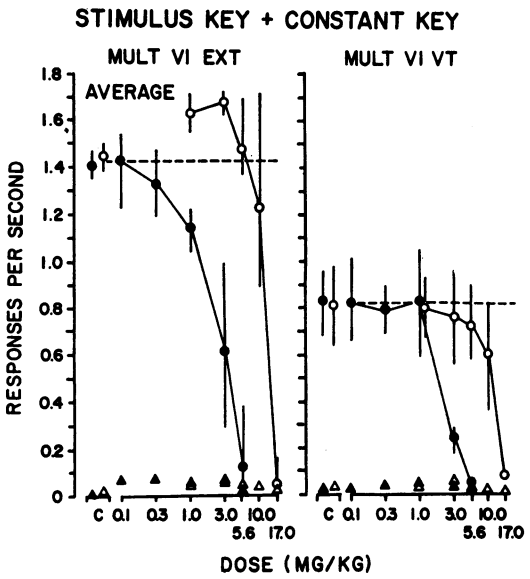

Fig. 7. Effects of *d*-amphetamine and pentobarbital on stimulus-key *plus* constant-key pecking under the two-key *mult* VI EXT and *mult* VI VT schedules. Points are means for two or three pigeons based on data in Figures 2 and 4. Vertical lines show ranges of means for individual pigeons. Other details are as in Figure 2.

(right panel). Neither drug increased this output. Thus, the effects of pentobarbital and *d*-amphetamine on responding under the conventional single-key schedule could be synthesized by summing responses on each key under the two-key schedule (compare Figures 5 and 7).

DISCUSSION

In the present study, responding by pigeons was maintained under either conventional single-key or two-key multiple schedules of food presentation. Under the single-key procedure, the stimuli associated with components of the multiple schedule appeared on the key on which pecks produced food. Under the two-key procedure, the stimuli appeared on one key while pecks on a second key produced food. Responding under each procedure was affected in analogous ways when the schedule was changed from *mult* VI EXT to *mult* VI VT, or when drugs were administered.

Schedule effects. Under the two-key *mult* VI EXT schedule, responding in the VI component was maintained on both the stimulus and constant keys. When the schedule was changed to *mult* VI VT, constant-key responding continued to occur, but stimulus-key responding declined to a very low level. These results confirm that responding under the two-key procedure was maintained by both the stimulus-reinforcer and response-reinforcer contingencies. That stimulus-key pecking was no longer maintained when the schedule was changed demonstrates the control of responding on this key by the contingency between keylight and food presentation, which existed only under the *mult* VI EXT schedule. That constant-key pecking was relatively unaffected by the same schedule change demonstrates the additional control of responding on that key by the contingency between key pecking and food presentation, which remained constant under both multiple schedules.

Under the single-key procedure, responding in the VI component declined markedly when the schedule was changed from *mult* VI EXT to *mult* VI VT. These results are consistent with those reported previously (Boakes, 1973; Halliday and Boakes, 1971; 1972; Weisman and Ramsden, 1973; Wilkie, 1972) and support an account of performance under conventional multiple schedules based on the joint maintenance of responding by stimulus-reinforcer and response-reinforcer contingencies. As predicted by that "additivity" account (*cf.* Schwartz and Gamzu, 1977), responding under the single-key multiple schedules was synthesized by adding together stimulus-key and constant-key responses under the two-key schedules (compare Figures 5 and 7, control).

Drug effects. The effects of the drugs also support an "additivity" account of performance under conventional multiple schedules. Under the two-key procedure, the effects of pentobarbital depended on whether responding was maintained on the stimulus or constant key. Some doses of pentobarbital increased stimulus-key responding in the VI component of the *mult* VI EXT schedule; these same doses either had little effect on or decreased constant-key responding. The selective effects of pentobarbital resulted in an increased total response output (the sum of pecks on both keys) in the VI component. When the schedule was changed to *mult* VI VT, stimulus-key responding was no longer maintained. Under this schedule, pentobarbital again decreased constant-key responding in the VI component, and hence decreased total

response output. Similarly, the rate-decreasing effects of *d*-amphetamine on pecking either key resulted in a decreased response output in the VI component of both the *mult* VI EXT and *mult* VI VT schedules. Thus, the effects of the drugs under the single-key multiple schedules were synthesized by summing responses on both keys under the two-key schedules (compare Figures 5 and 7). These drug effects are consistent with those reported previously for pentobarbital and *d*-amphetamine under a conventional *mult* VI EXT schedule (Dews, 1958; Hearst and Vane, 1967), but differ from those reported for *d*-amphetamine under a *mult* VI VT schedule (Thompson and Corr, 1974). In the latter study, some doses of *d*-amphetamine increased responding in the VI component.

The failure of *d*-amphetamine to increase responding in the VI component of either the single-key or two-key multiple schedules is not surprising. Dews (*e.g.,* Dews, 1958; Dews and Wenger, 1977) offered compelling evidence that the behavioral effects of amphetamine depend critically on the control rate of responding in the absence of drug. According to that analysis, low control rates of responding are increased by amphetamine, whereas higher control rates are not. The present results are consistent with this general finding; *d*-amphetamine often increased low rates of responding (as in the EXT and VT components), but decreased higher rates of responding in the VI component. This interpretation may also account for the differences in the effects of *d*-amphetamine observed here and by Thompson and Corr (1974); control rates of responding in the VI component were lower in the Thompson and Corr study. However, a similar interpretation does not describe adequately the effects of pentobarbital obtained here. Under the single-key procedure, for example, pentobarbital increased the high rates of responding in the VI component of the *mult* VI EXT schedule, but decreased the lower rates of responding in that component of the *mult* VI VT schedule. Under the two-key procedure, pentobarbital selectively increased stimulus-key responding in the VI component regardless of whether control rates of responding on the two keys were similar (P-72, P-287) or dissimilar (P-21).

Some recent experiments (see review by McKearney and Barrett, 1977) have shown that the effects of drugs on schedule-controlled behavior can depend on the environmental context in which behavior occurs. The present results also can be viewed in this way. The effects of pentobarbital on responding in the VI component under the single-key procedure depended on the context in which that component appeared; that is, on whether the alternate component was EXT or VT. The results obtained under the two-key procedure suggest that this context-dependent drug effect could be understood more fully in terms of the selective effects of pentobarbital on responding maintained by the contingencies between stimulus and reinforcer and between response and reinforcer. The role of the contingency that maintains responding in determining the behavioral effects of drugs has not yet received extensive study. Recent reviews (Hearst and Jenkins, 1974; Rachlin, 1973; Schwartz and Gamzu, 1977), however, attest to the ubiquity of stimulus-reinforcer and response-reinforcer contingencies as sources of behavioral control in a variety of experimental settings. Studies of the behavioral effects of drugs may benefit from an analysis in terms of responding maintained by these contingencies. Such an analysis is particularly relevant in situations in which the effects of drugs depend on complex relations between stimuli, responses and reinforcers, as in the present study.

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